REMARKS

General:

Claims 1-2 and 4-7 are pending in the application. Claims 4-7 are withdrawn from consideration as directed to a non-elected species.

Claim 1 is amended to specify an average grain size less than 8 μm. Support for the amendment is found in Table 1, Example 3.

Claim 7 is amended to correct a word processing error in the previous amendment. Support for the correction is found in original claim 3.

No new matter is added by this amendment.

Election / Restriction:

Election was required between claims 1-2 to a titanium copper alloy and claims 4-7 to a method of manufacturing the alloy.

Applicants confirm the previous provisional election of claims 1-2.

The election requirement is traversed. The examiner argues that "the process as claimed [in claims 4-7] can be used to make other and materially different product such as aluminum alloys." It is respectfully pointed out that claims 4-7 are explicitly directed to "a method of manufacturing the titanium copper alloy according to claim 1 or 2" which excludes making materially different aluminum alloys.

Double patenting:

The provisional double patenting rejection is noted. However, the present application is the earliest-filed of the three applications. Absent the future development of

the peculiar circumstances discussed in MPEP § 804.II.B.1.(b), it is unlikely that any double-patenting rejection will lie against the claims of the present application.

35 U.S.C. § 103 rejections:

Claim 1 was rejected as obvious over commonly-assigned Japanese published patent application no. JP 2001-303158 A (Yamamoto). Yamamoto is cited as describing a titanium copper alloy with 0.5 to 5.0 % by mass titanium, and a grain size from 5 to 35 µm, and a tensile strength of at least 800 MPa. Yamamoto is silent as to the amount and grain size of any Cu/Ti intermetallic compound.

The present invention, as claimed in claim 1, provides an alloy having 1.09 to 4.5 % by mass of Ti, average grain size 10 µm or less, and a tensile strength of 890 MPa or more, in which the diameter of the intermetallic compound particles is 3 µm or less, and the average number of intermetallic compound particles having a diameter of 0.2 to 3 µm is 700 or less per 1000 μm^2.

The examiner argues that the claimed range of 700 particles or less includes zero, and overlaps with the indefinite range of Yamamoto, and contends that creates a *prima facie* case of obviousness.

As a preliminary matter, MPEP § 2123 does not appear to assist the examiner. Although the headline refers to "rejection over prior art's broad disclosure," the text of the section is entirely concerned with rejection over non-preferred embodiments, and does not apply to the present case.

With reference to the examiner's citation of MPEP § 2132.03, Yamamoto does not anticipate claim 1 because Yamamoto does not teach a specific example within the claimed range or teach an overlapping range with specificity. Yamamoto does not teach the presence of a definite quantity of intermetallic compounds, but the absence of teaching is not the teaching of absence. Yamamoto does not teach an alloy in which the number of intermetallic compound particles is zero. (In fact, as may be seen from the attached phase charts, Yamamoto's alloy is presumed to consist predominantly of the intermetallic

compound $CuTi_{3\text{-}4}$, but the physical structure is unknown.) MPEP § 2132.03 clearly acknowledges that a narrow range may be both new and non-obvious over prior art of a broad range. In the present case, where Yamamoto's range is effectively unbounded, the claimed range of 0 to 700 particles per 1000 μm^2 is narrow.

The present invention is characterized over Yamamoto by homogeneously dispersed fine Cu/Ti intermetallic compound particles, specifically, by 700 or less particles per 1000 μm^2 having a diameter from 0.2 to 3.0 µm, and an average grain size of the alloy of 8 µm or less. This combination of features, which is not taught or suggested by Yamamoto, gives an alloy with excellent strength and bendability that is not taught or suggested by Yamamoto.

The improved properties of the present invention are achieved by carefully controlled hot rolling and solution treatment, which are not taught or suggested by Yamamoto. As recited in original claim 3 (and present claim 7), the hot rolling is carried out at a temperature of 700 °C or more, which makes it possible for the coarse intermetallic compounds to dissolve in the matrix. As recited in original claim 3 and described at page 8, lines 13-25, the solution heat treatment is carried out at a temperature between T-50 and T+10 °C, where T is the temperature at which the solubility of Ti in Cu is equal to the concentration of Ti in the actual alloy.

In contrast, Yamamoto does not indicate the temperature of hot rolling. However, it can be inferred from the solution heat treatment for 1 hour at 1173 K (900 °C), see paragraph [0014] on page 5, that the hot rolling temperature is substantially lower than 700 °C, allowing coarse intermetallic compound to remain, so that the long, hot heat treatment is necessary for dissolution thereof. As may be seen from the right-most column in Table 2 (Fig. 1) of Yamamoto, this long, high temperature heat treatment results in grain sizes greater than 10 µm. (Examples 10-14, some of which have a small grain size, are comparison examples. As may be seen from the right-most column of Table 3 (Fig. 1), these examples broke in the 90° bending test.

Thus, Yamamoto does not provide any motivation or suggestion to control the hot rolling and solution treatment conditions so as to obtain a titanium copper alloy in which the average number of intermetallic compound particles having a diameter of 0.2 to 3.0 µm is

700 or less per 1000 μm^2, and in which the average grain size of the alloy is 10 μm or less. The present invention, as claimed in claim 1, is therefore believed not to be obvious over the teachings of Yamamoto.

Claims 1 and 2 were rejected as obvious over commonly-assigned JP H04-231447 A (Toe et al.) in view of Yamamoto and further in view of JP S61-124544 A (Senda et al.). The examiner asserts "as are evinced by the cited references that the recited properties are merely conventional properties that inherently possessed by the conventional alloy composition and steps of age-hardening." In fact, however, Toe neither discloses nor suggests any limitation on the number of intermetallic compound particles having diameters of 0.2 to 3 μm. Nor does Toe disclose or suggest an alloy having an average grain size of 8 μm or less. The examiner cites Yamamoto's discussion of prior art as suggesting that a Cu_3Ti phase can form during age hardening, but fails to show that phase forms as intermetallic compound particles, and fails to show that the alloy being discussed by Yamamoto is the same as that described by Toe. The examiner cites example O of Senda as showing "area % and sizes of intermetallic compound in Ti containing Cu alloy," but that alloy is in fact titanium brass (15% Zn, 7% Al), not titanium copper, and the skilled person would not combine the teachings of Senda with either Toe or Yamamoto. In addition, it is respectfully pointed out that the examiner's argument does not comply with the strict standards for inherency, and proof of inherency, laid down by the case law cited in MPEP § 2112.

Thus, there is no disclosure or suggestion in the cited references of an alloy having the combination of features recited in claims 1 and 2, or the improved properties arising from those features, and the present invention as claimed is believed to be non-obvious over the references.

Conclusion:

In view of the foregoing, reconsideration of the examiner's objections and rejections and an early notice of allowance of all of claims 1-2 and 4-7 are earnestly solicited.

Respectfully submitted,

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Monograph Series on Alloy Phase Diagrams

Phase Diagrams of Binary Copper Alloys

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Cu-Ti (Copper-Titanium)

By J.L. Murray

Equilibrium Diagram

The Ti-Cu phase diagram shows a depression of the melting points of both elements, so that the liquidus has a minimum near the center of the diagram. In the composition range 50 to 67 at.% Cu, a series of closely spaced, structurally related compounds appear. There are also the Ti-rich and Cu-rich compounds Ti_2Cu and $TiCu_4$. Experimental phase diagram data are uneven in accuracy, in the sense that the structures and compositions of the compounds have been carefully determined and verified, but many of the phase boundaries involving liquid and solid solution phases were examined in only one study [52Jou]. Metastable phase equilibria have been investigated thoroughly; studies cover the decomposition of supersaturated cph and

Table 1 Special Points of the Assessed Ti-Cu Phase Diagram

Reaction	Composition of the respective phases, at.% Cu			Temperature, °C	Reaction type
L ↔ βTi		0		~1670	Allotropic
βTi ↔ αTi		0		882	Melting
(βTi) + L ↔ Ti_2Cu	13.5	36.5	33.3	1005 ± 10	Peritectic
(βTi) ↔ (αTi) + Ti_2Cu	5.4	1.6	33.3	790 ± 10	Eutectoid
L ↔ Ti_2Cu + TiCu	43	33.3	48	960 ± 5	Eutectic
L ↔ TiCu		50		985 ± 10	Congruent
TiCu + L ↔ Ti_3Cu_4	52	62.5	57.1	925 ± 10	Peritectic
Ti_3Cu_4 + L ↔ $TiCu_2$	57.1	71	66.7	890 ± 10	Peritectic
Ti_3Cu_4 + $TiCu_2$ ↔ Ti_2Cu_3	57.1	66.7	60	875 ± 10	Peritectoid
L ↔ $TiCu_2$ + $\beta TiCu_4$	73	66.7	78	875 ± 10	Eutectic
$TiCu_2$ ↔ Ti_2Cu_3 + $\beta TiCu_4$	66.7	60	78	870 ± 10	Eutectoid
L + (Cu) ↔ $\beta TiCu_4$	77	92	80.9	885 ± 10	Peritectic
$\beta TiCu_4$ ↔ Ti_2Cu_3 + $\alpha TiCu_4$	~78	60	~78	~400	Eutectoid
$\beta TiCu_4$ ↔ $\alpha TiCu_4$ + (Cu)	~80.9	~80.9	99.5	~500	Peritectoid
L ↔ Cu		100		1084.62	Melting

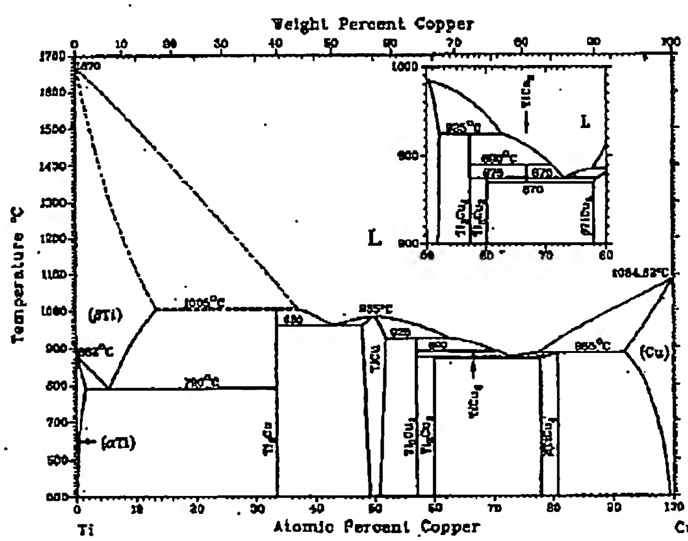

Fig. 1 Assessed Ti-Cu phase diagram.

fcc solid solutions and the formation of noncrystalline alloys in the composition range 30 to 75 at.% Cu.

The equilibrium solid phases of the Ti-Cu system are:

- The solid solutions—cph (αTi), the stable form of Ti below 882 °C; bcc (βTi), the stable form of Ti between 882 °C and the melt; and fcc (Cu). The maximum solubilities of Cu in (αTi) and (βTi) are 1.6 and 13.5 at.% at 790 and 1005 °C, respectively. The maximum solubility of Ti in (Cu) is 8 at.% at 885 °C.

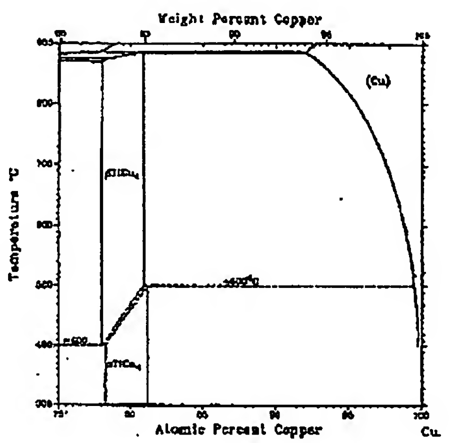

Fig. 2 Detail of the TiCu4 polymorphic transformation.

- The essentially stoichiometric compound Ti_2Cu, with the $MoSi_2$ structure.
- TiCu ($B11$ structure), which has a homogeneity range of 48 to 52 at.% Cu and melts congruently at 985 °C.
- The essentially stoichiometric compounds Ti_3Cu_4, Ti_2Cu_3, and $TiCu_2$, with related crystal structures.
- High- and low-temperature polymorphs $\beta TiCu_4$ and $\alpha TiCu_4$, each with the approximate homogeneity range 78 to 80.9 at.% Cu. Metastable ordered structures can form in this composition range before the appearance of equilibrium $\beta TiCu_4$.

The assessed phase diagram is shown in Fig. 1, and a detail of the $\beta TiCu_4 \rightarrow \alpha TiCu_4$ transformation is shown in Fig. 2. Numerical values of the special points of the diagram are summarized in Table 1.

Ti_2Cu and (βTi)/L Boundaries

There has been disagreement about whether the most Ti-rich compound has the stoichiometry Ti_3Cu or Ti_2Cu. The existence of Ti_2Cu with the bct $MoSi_2$ structure and the absence of Ti_3Cu are now established. [51Kar] found a nearly pure compound at 25 and 27.5 at.% Cu, but the alloys had been severely contaminated. The stoichiometry Ti_3Cu also was assumed by [70Lut] and [52Ran], although without any direct evidence. [67Gar] claimed to have established the existence of both Ti_3Cu and Ti_2Cu by means of XRD and optical microscopy, but they did not give enough details of the experiments to assess the accuracy of their work.

Evidence for the existence of Ti_2Cu was found by [52Jou], [61Enc], [62Mue], [63Mue], [70Blk], and [71Wil]. [52Jou], [61Enc], [62Mue], and [63Mue] were able to prepare essentially single-phase Ti_2Cu alloys. [61Enc], [62Mue], and [63Mue] related the structure of Ti_2Cu to that proposed by [51Kar] for "Ti_3Cu," which strongly suggests that the same phase was observed in all of these studies. The work of [61Enc], [62Mue], and [63Mue] established the existence of Ti_2Cu.

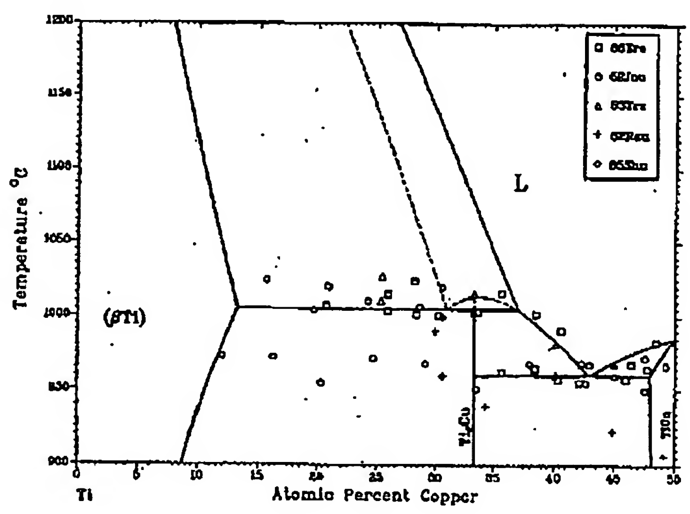

Fig. 3 Detail of experimental liquidus data for Ti-rich alloys.

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The output of the International Data Program for Alloy Phase Diagrams contained in this monograph has been reviewed by the Office of Standard Reference Data and accepted as a product of the National Standard Reference Data System.

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